CCNU Intent to sPHENIX MVTX and Open Bottom Physics Program

Yaping Wang

Central China Normal University (CCNU)

Outline

- Introduction to CCNU
- Intent to sPHENIX MVTX and Open Bottom Physics Program
  - Activities on ALICE/ITS Upgrade
  - Feasibility and Time Schedule for sPHENIX MVTX
  - Budget Estimation for sPHENIX MVTX
- Summary and Outlook

Introduction to CCNU – Background in HI Physics

Central China Normal University (CCNU) founded in 1893.

Research on heavy-ion physics:

- **Quark matter theory**
  - ✓ pQCD
  - ✓ Lattice QCD
  - ✓ Jet physics
  - ✓ Condensed matter
- **High energy collision experiments**
  - ✓ Experimental measurements (Bulk, C&F, critical point, jet, HF, etc.)
  - ✓ Detector and readout electronics R&D
- **High energy collision phenomenology**
  - ✓ Heavy flavor
  - ✓ C&F
  - ✓ Quark recombination

Introduction to CCNU – Contributed HI Experiments

International Collaborations on High Energy Nuclear Physics

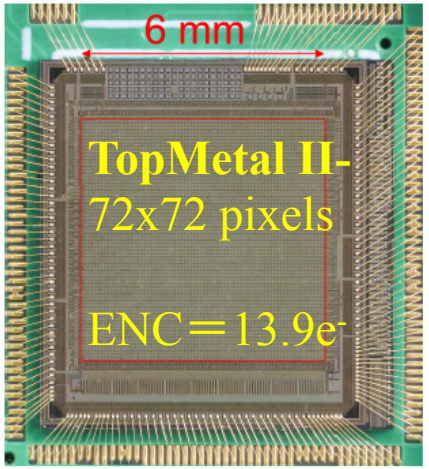
CCNU

Introduction to CCNU – Pixel Lab At CCNU (PLAC)

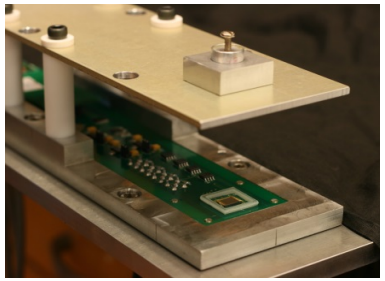
The PLAC was founded in 2011 (Dr. Nu Xu)

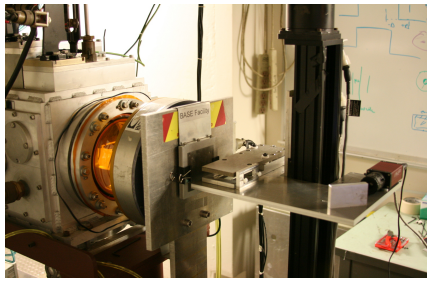
PLAC
Pixel Laboratory at CCNU

ALICE *ITS* | **CEPC** *VTX* | **STAR** *HFT* | **sPHENIX** *MVTX*



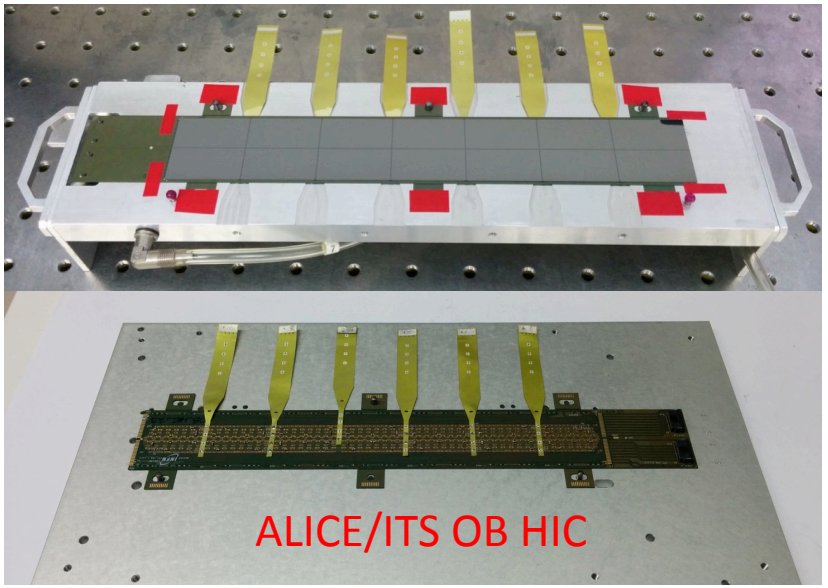
- **TopMetal (CSR/CEE beam monitor, dark matter experiment, non-neutrino double beta decay, …)**
- **MAPS chip design (CEPC/VTX, etc.)**
- **High precision FEE (hFEE)**

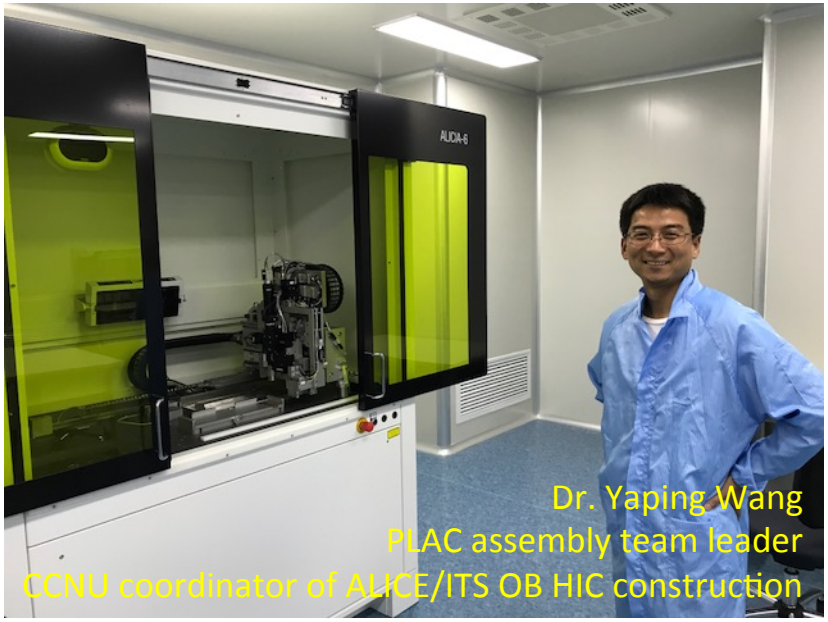




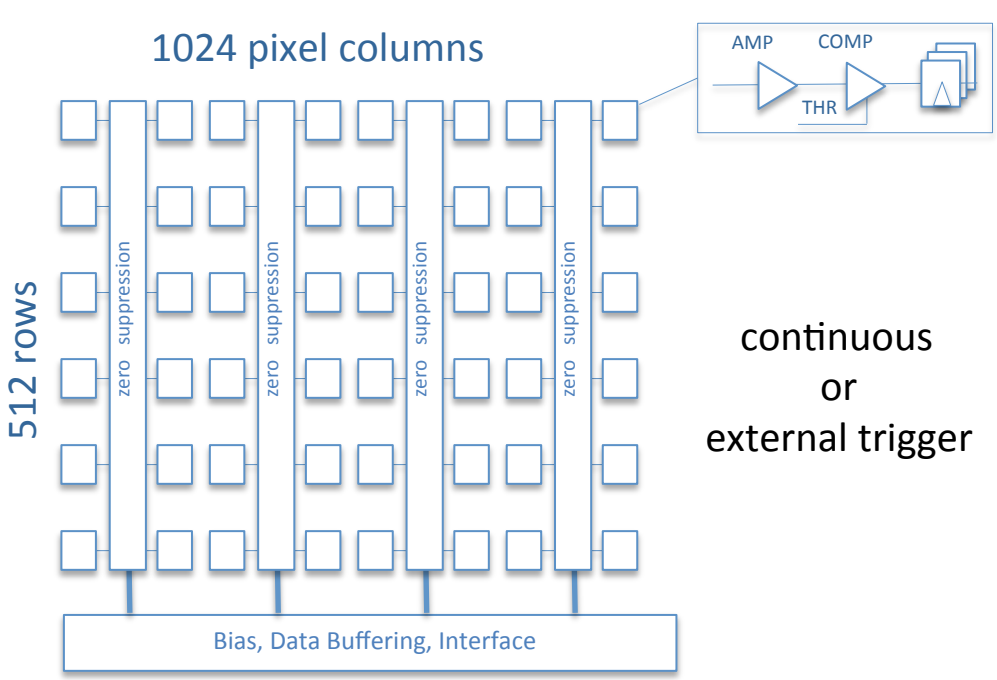
CCNU Activities on ALICE/ITS Upgrade

- ALPIDE chip design since 2012
- 20% ALICE/ITS OB HIC assembly & testing
- Clean room was constructed and run in good status since November, 2016
  - ✓ Ground floor (vibration velocity RMS ~ 3 μm/s)
  - ✓ Temperature/humidity controllable
  - ✓ ISO6 clean level ~ 70 m^2 (2.6 m head room) + ISO7 clean level ~ 20 m^2 (2.9 m head room)
  - ✓ Grounding terminals provided (ESD protection)
  - ✓ Gas supply system (4 channels)
- IBS ALICIA-6 machine and F&K Delvotec G5 wire-bonding machine installed
- ITS OB HIC assembly & testing team has been prepared/trained in Wuhan/CCNU.

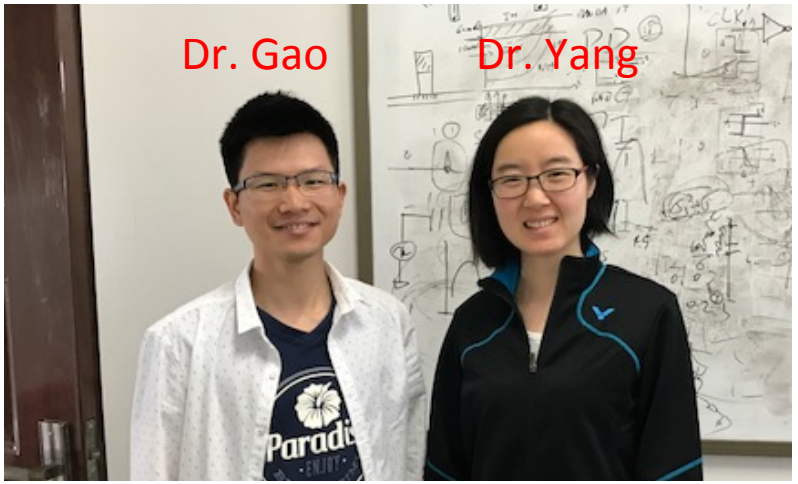


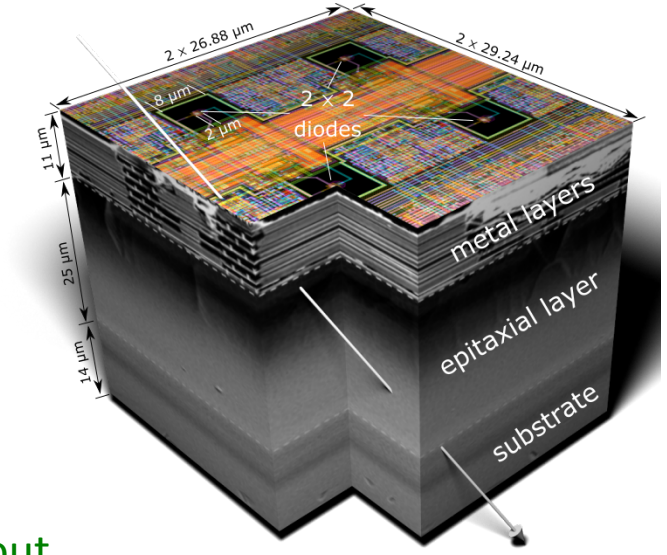


CCNU Activities on ALICE/ITS Upgrade – ALPIDE Chip Design



continuous
or
external trigger





- Pixel pitch: 29µm x 27µm
- Ultra-low power (entire chip): < 40mW/cm^2
- Global shutter: triggered acquisition (200 kHz) or continuous (integration time <10µs)

Efforts on chip design from Wuhan/CCNU (Since 2012):

(1) **Matrix readout architecture:** lower power, fast readout

(2) **Pixel analog front-end:** mis-match reduction, charge threshold reduction, lower noise

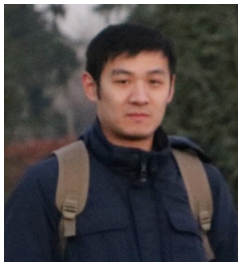
CCNU Activities on ALICE/ITS Upgrade – Funding and Manpower

➢ Funding Status

- **CCNU funding** (2013 ~ till now): clean room construction/preparation/running, machines (ALICIA-6, G5 Delvotec machine, etc.), manpower salary and traveling (students and technicians).
- **MOST funding** on ITS upgrade project (Jan. 2017 ~ Dec. 2021): MAPS chips, tooling/jigs, consumables, traveling, technicians/students salary during production phase, etc.

➢ Manpower preparation (technicians and students)

- **2 mechanical technicians** (Mr. Daming Sun, Mr. Kai Wang): trained at Bari/INFN and locally
- **1 electronic technician** (Mr. Jun Liu) : trained at Bari/INFN and locally
- **2 phD students** (Mr. Mangmang An, Mr. Shuguang Zou): stayed at CERN for 1 year
- **4 master students** (Ms. Wenjing Deng, Ms. Yan Wang, Mr. Biao Zhang, Ms. Peipei Zheng)


Mangmang An
HIC assembly & test

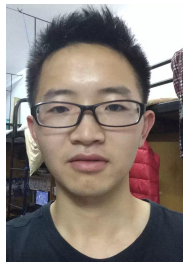

Wenjing Deng
HIC test &
MAM operation


Jun Liu
HIC test &
MAM operation


Daming Sun
HIC assembly


Kai Wang
HIC assembly

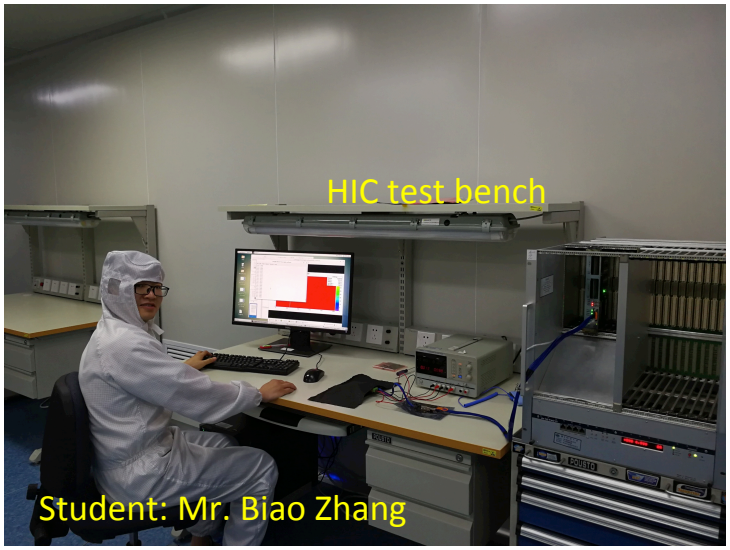

Yan Wang
Vision control system
R&D

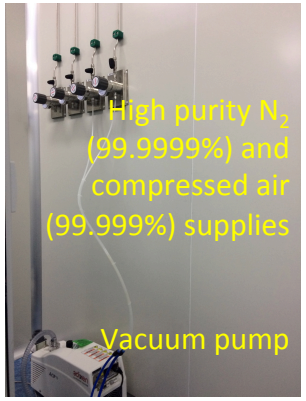

Biao Zhang
HIC test &
MAM operation

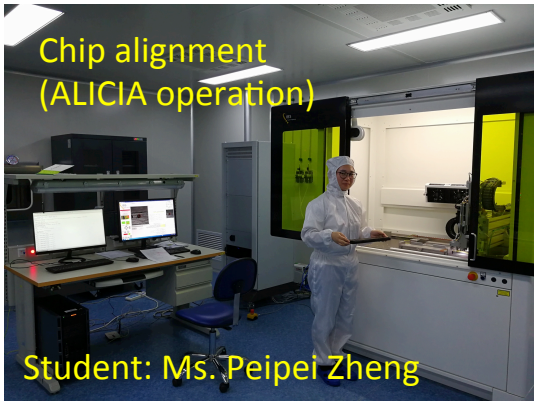

Peipei Zheng
HIC test &
MAM operation


Shuguang Zou
ALPIDE test

CCNU Activities on ALICE/ITS Upgrade – Wuhan Lab







CCNU Activities on ALICE/ITS Upgrade – OB HIC Production

Layer	Stave	Half-stave	HIC	Chip
L3	24	48	192	2688
L4	30	60	240	3360
L5	42	84	588	8232
L6	48	96	672	9408
Total	54 90	108 180	**1692**	23688

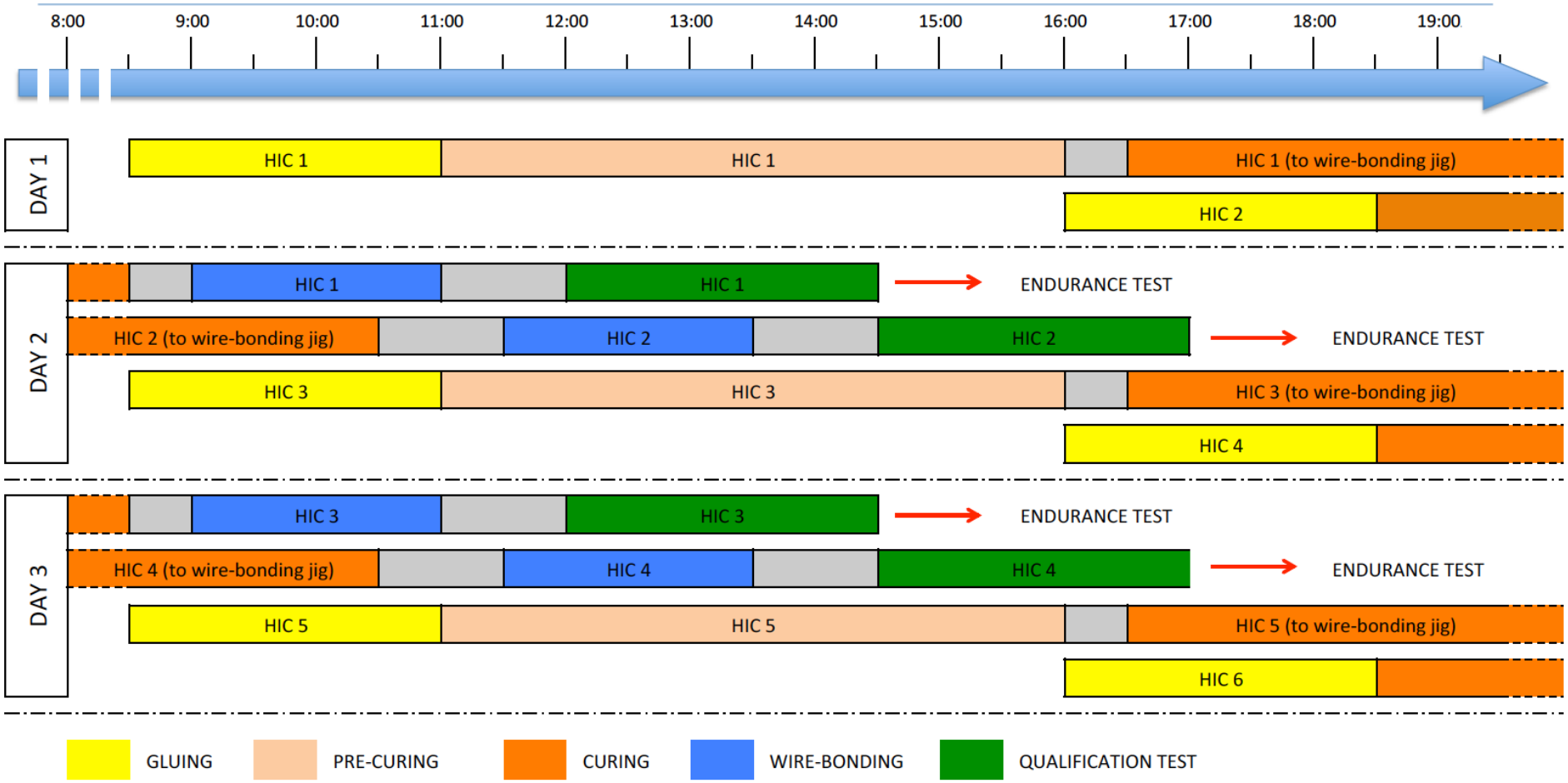
Assuming:

20% spares, i.e. ~ 350 additional working HICs ☞ ~2042 working HICs

80% yield, i.e. HICs with 14 fully working chips ☞ **~2550 HICs** overall production

Assuming equal sharing, each construction site (Bari, Liverpool, Pusan-Inha, Strasburg and Wuhan/CCNU) should assemble and characterize ~500 HICs.

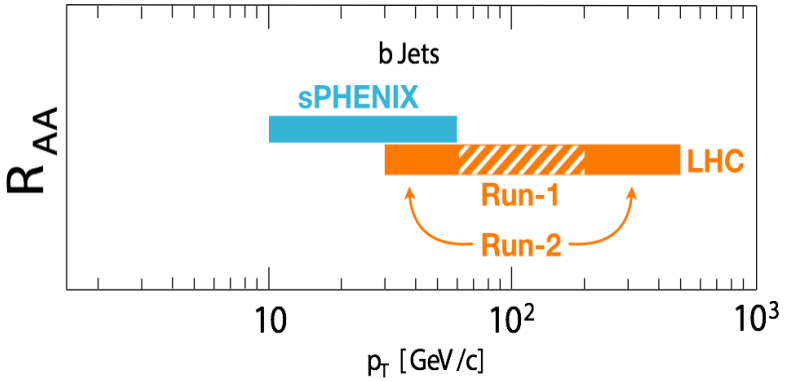
CCNU Activities on ALICE/ITS Upgrade – Production Rate

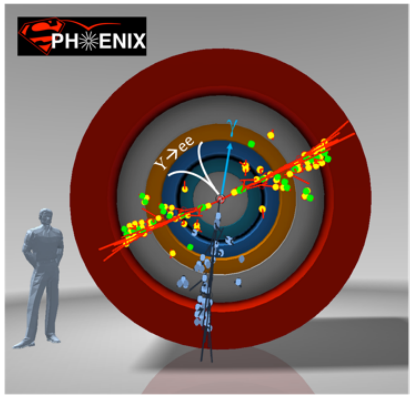


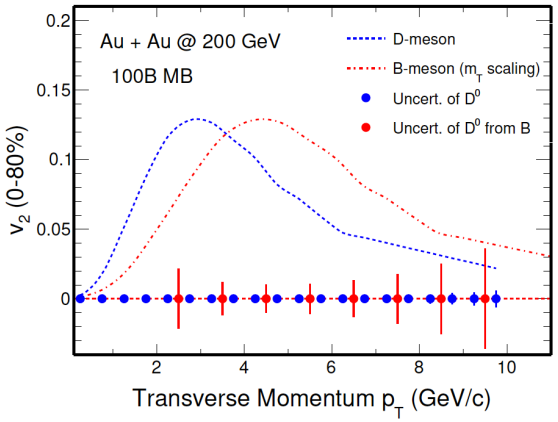
- ✓ Production rate is 2 HICs/day/site
- ✓ 10+ months production at Wuhan/CCNU for 500 OB HIC modules
- ✓ Pre-series production will started in July, 2017
- ✓ Series production is estimated to be started in August, 2017, and end in June, 2018

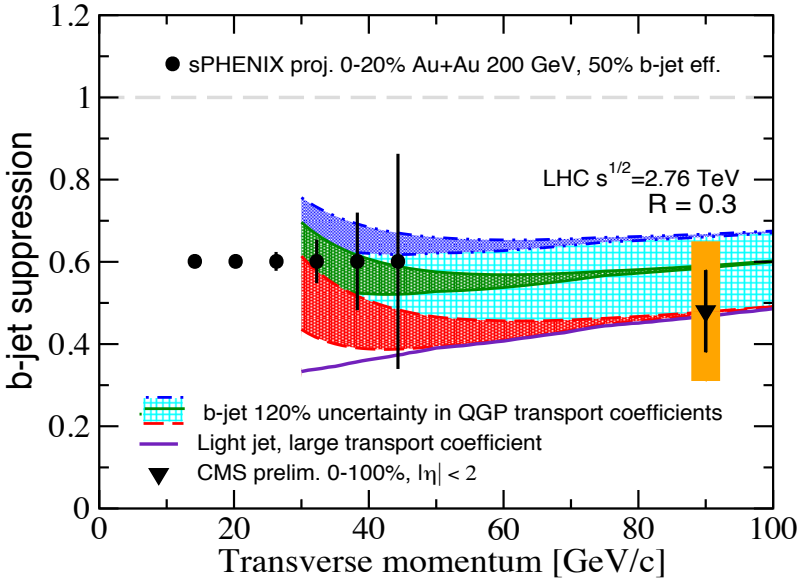
Open bottom physics with sPHENIX MVTX

- sPHENIX is the next flagship heavy ion physics experiment in US.
  - B-jets & B-hadrons
  - HF-jet correlations
  - Λ_c production and flow
- The sPHENIX/MVTX, combined with particle identification will allow precision measurement of bottom hadrons and HF-jets at RHIC.
- This is important for extracting the quark mass dependent energy loss and understanding the properties of the medium created in high-energy nuclear collisions at RHIC.









Ref.: Dr. *Ming Liu's seminar at CCNU, May, 2017*

Feasibility and Time Schedule for sPHENIX MVTX

Draft plan discussed with Dr. Ming Liu during his visit at CCNU this May:

- Wuhan lab can be used for MVTX HICs production after June, 2018
  - 3 months replace jigs, training at CERN
  - Starting ~ Sep. 2018, ~2 HICs per day, → 35days, 2-3 months
  - Technicians and students transferred from ALICE/ITS project
- Stave assembly at Wuhan/CCNU (68 staves in total)
  - Stave space frame fabricated at CERN (by 2017)
  - replace jigs (copy from CERN ITS/IB), training at CERN
  - Stave assembly & testing → 4-6 months
- Mechanical system integration
  - Plan to have a phD student to work on sPHENIX integration effort
    - Visit LANL 6-12 months on preliminary conceptual design for the MVTX/INTT/TPC

Feasibility and Time Schedule for sPHENIX MVTX

- 6 faculties are grouped for the sPHENIX MVTX and B physics program:
  - Dr. Yaping Wang (PI, 30%): ALICE PHOS/EMCal FEE, ALICE DCal construction, STAR HFT/IST, now leading CCNU effort on ALICE/ITS Upgrade, HF physics @STAR
  - Dr. Daicui Zhou (20%): ALICE-China team coordinator, HF & Jet physics@ALICE
  - Dr. Shusu Shi (20%): STAR HFT/PXL, Bulk & HF physics @STAR
  - Dr. Dong Wang (30%): ALICE PHOS/EMCal FEE and Trigger electronics, ALICE/MFT
  - Dr. Ping Yang (30%): ALPIDE MAPS chip design on analogy circuit, CEPC VTX
  - Dr. Chaosong Gao (30%): ALPIDE MAPS chip design on digital circuit, CEPC VTX
- Additional postdocs and students will join the efforts in due time.

Budget Estimation for sPHENIX MVTX

- Labor costs:
  - −Technicians: 20K CNY/person/month * 3 persons * 9 months ~ $ 80K USD
  - −Students: 4K CNY/person/month * 5 persons * 9 months ~ $ 27K USD
- Tooling/jigs (HIC assembly/testing + stave assembly) ~ $ 20K USD
- Consumables (glue, gas, bonding wires, etc.): ~ $ 20K USD
- Shipping MAPS/HICS/STAVES and packing: ~ $ 40K USD
- Traveling and Training
  - Training at CERN: 100 EURO/person•time/day *30 days * 6 person•time ~ $ 20K USD
  - Travel to CERN: 5K EURO/person•time * 6 person•time ~ $ 35K USD
  - Travel to US: 100 USD/person•time/day * 60 day•time•person + 25K USD ~ $ 31K USD
- MAPS/FPCs: provided by sPHENIX
- Others (Customs duty, …) ~ $ 14K USD
- In total: ~ $287K USD

Summary and Outlook

- The CCNU lab can be used for the sPHENIX MVTX assembly after June, 2018!
- Experienced technicians and students are available after the ALICE/ITS HIC assembly/testing task.
- Plan to have 1 phD student work on mechanical system integration with LANL/ LBNL group.
- Estimated 6~9 months for MVTX assembly from MAPS to stave at Wuhan/ CCNU, with budget amount to ~ 300K USD.
- 6 CCNU faculties are grouped for the sPHENIX MVTX and open bottom physics program.

Thanks for your attention!